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WEMBLEY.

THE British Empire Exhibition held at Wembley during this year has now ended and the question uppermost in the minds of the people in connection with this, the world's greatest exhibition, is, "Has the Exhibition been a success"? Many business men, who regard the venture in exactly the same way as they would any commercial undertaking, are content merely to total up the expenditure and receipts, and from the resulting adverse balance, they arrive at the conclusion that the Exhibition has been a dismal failure. This is undoubtedly an unfair method of arriving at a decision and the only true criterion is to consider whether the Exhibition has served the purpose for which it was originally intended. To form a judgment upon such a question it is necessary to trace briefly the development of the idea which resulted in the staging of the Exhibition.

This idea was originally suggested by that great Empire builder Lord Strathcona, who in 1913 proposed that an Exhibition should be held in London in order to demonstrate the resources and manufacturing strength of the Empire. The proposal met with a very favourable reception but, like many another project, it became obscured in the shadow of war, when the whole strength and energy of the Empire were temporarily diverted from peaceful pursuits to the prosecution of the struggle against our enemies. The Dominions and the Colonies nobly responded to the call of the Mother Country and amid the trial and suffering of the world's bloodiest war the various units comprising the Empire became more keenly aware than ever before of their kinship.

With the termination of the war the idea of the Exhibition was taken up with greater enthusiasm than would have been possible before, and eventually materialised in the magnificent display at Wembley. The objects of the Exhibition as set out in the official literature published before the opening, were, briefly,

(1) To find, in the development and utilization of the raw materials of the Empire, new sources of Imperial wealth.

(2) To foster inter-Imperial trade and open fresh world markets for Dominion and home products.

(3) To make the different races of the British Empire better known to each other and to demonstrate to the people of Britain the almost illimitable possibilities of the Dominions, Colonies, and Dependencies overseas.

From these specific points of view, which are surely the only true criteria, there can be no doubt that the British Empire Exhibition has been emphatically a success. We have often been assured that the British Empire is capable of producing all the commodities capable of satisfying man's wants from the cradle to the grave, but it needed some such display, which in a singularly happy phrase the Prince of Wales described as "the shop window of the Empire," to bring the fact vividly home to the reputedly unimaginative mind of the average Britisher.

At Wembley the visitor was able to feast his eye upon the products of the most comprehensive unit ever known to history, representing every stage of industrial, commercial and agricultural development from the Stone Age to the twentieth century; including every type of climate from the Arctic in the North to the Antarctic in the South; embracing the most astonishing varieties of race, religion and language. Manufacturers, merchants and financiers were all able to observe the fact that the Empire is capable of supplying them with all

their commercial wants, and they were able to appreciate the enormous opportunities that await them overseas.

The general undifferentiated visitor, important as the ultimate consumer of the products displayed in the Exhibition, was able to see and to sample products of the Empire, many of which were previously sold under fictitious trade names, and the removal of much of the prejudice which hitherto existed against such produce, cannot fail to react favourably upon the marketing of Empire products. A demand was stimulated and new channels of trade created for commodities not yet brought into general use.

The development of inter-Imperial trade is a logical sequel to the development and utilization of the raw materials of the Empire. There is no doubt that inter-Imperial trade has been extended as a result of the gathering together of the various units comprising the Empire, into one great Exhibition. Large orders were immediately forthcoming, but the real significance lies in the fact that definite lines of inter-Imperial trade have been established, the full cumulative effect of which will not be felt for some time to come. Apart from the purely inter-Imperial aspect, large orders have come from practically every foreign country in the world. These orders, considerable though they are, must sink into insignificance when compared with the ultimate benefits that must accrue to the Empire as a whole.

Large numbers of people have come from all parts of Great Britain, from her Dominions and Colonies, and every other part of the inhabited world, to see what the British Empire is, what it can produce, and what it has to sell. The most amazing ignorance of the extent and resources of the Empire existed in every class of the community prior to the Exhibition and while not even the most sanguinary would presume that all this ignorance has been swept away, it can safely be said that the people of the Empire are now more cognisant of the disposition and magnitude of the Empire than ever before. Out of understanding is born sympathy, and with sympathetic understanding the possibilities of the Empire are illimitable. Mr. Hughes, Prime Minister of Australia, when on an official visit to England declared that, "in Australia they knew very little of England and England knew even less of Australia," and that, "if he knew of Australia only what he gathered from the newspapers here, it would be the last place on God's earth to which he would wish to go." What was true of Australia was also true of other countries within the Empire and the fact that the Exhibition has done much to sweep away this prevailing misunderstanding is evidenced, for example, by the statement of one official from Kenya who said that he knew of cases where parents, considering careers for their sons who are now at school in England, are making plans for sending them to Kenya to work.

For the tropical portions of the Empire the Exhibition has had a special significance, since it marks a definite reaction from the antagonistic attitude adopted in Great Britain towards her colonies in the middle of the 19th century, when they were regarded as antiquated encumbrances from the past, and when it was said that any party would rather lose a colony than a division. In the self-governing Dominions where it was known that Europeans could settle and rear healthy families, sufficient advertisement was given by the mere numbers of Europeans leaving Britain to settle in those countries, but with regard to the tropics, where the proportion of Europeans is small, and where the difficulties of permanent European settlement have been greater, the ignorance as to climate and health conditions had not been dispelled. They still remained unknown factors, and "pestilential areas" in the minds of people. Men's heads were full of the tales of their youth, of emigrants 'dying like flies,' and others returning ruined in health after a short period in the tropics, and these unfortunate features were naturally attributed to unalterable factors of climate. The climate has remained much the same, but, as was pointed out in the November issue of this Journal ("Colonization and Tropical Climate" Vol. 1, No. 11, pp 162-3) modern methods of sanitation and drainage, research into tropical diseases and medicine, and effective means of combating disease-spreading insects, have all helped to demonstrate the fact that it was not the climate which killed, but the failure to understand tropical conditions. Areas once regarded as the "white man's grave" have now become the white man's sanatorium.

The trend of medical opinion is towards the belief that there is no physiological reason why the white races should not inhabit the tropics and this has been brought into prominence by the Exhibition. In the Tropics there lie some of the richest and largest areas of commercially undeveloped land in the world. Their potential wealth is almost unlimited and they await but the application of European capital and energy to make their resources available for the use of mankind. The tropics must loom larger and larger in world economics since their products are becoming more and more important for the well being of the world at large. When we remember that the tropics supply us with the whole of our rubber, cane sugar, palm oil, copra and coffee; with most of our rice, a large proportion of our tea, and many other commodities, and when we remember that they are capable of supplying us with hundreds of other products whose commercial values are not yet fully appreciated, we begin to realise the fundamental importance of the tropics. They need only advertisement, capital, and energy to put their useful commodities at the disposal of man.

It is essential that we should realise that the British Empire Exhibition is merely a means to an end and not an end in itself. As an advertisement and a stimulant it has been eminently successful, but the ultimate test of its utility depends upon whether or not the interest aroused is sufficiently maintained to produce definite and lasting results.

The Exhibition has been the occasion of many meetings and reunions of men from overseas, and it is profoundly to be hoped, that when they return to the lands of their adoption, they will apply their energy to the solution of the problems raised, and that the Mother Country will send out successive relays of men and capital to assist them, for upon such factors depends the success of the Exhibition. It is to be hoped that when the history of the Exhibition is written it will be found that Wembley was an important element among the causes leading to a revival of trade after the depression engendered by the Great War.

HONEY, A CROP FOR THE TROPICS.

The value of honey as a food and as a delicacy is probably not fully recognised by the consuming public. Nor is its importance as a possible product realized by planters and other residents in the tropics. From early times honey has been used by man as a delicacy and as a food, while the bee has been held up as a model of industry.

Honey has a special food value for children and those who have delicate digestions ; it has a particular use, a sweetening for cakes and other foods and in the preparation of confections and sweets, while it forms a welcome change from the usual jams and syrups as a table sweet.

The importance of the honey-bee in connection with the pollination of flowers and the assurance of fruitfulness of many species of plants is another point not always recognised. In temperate countries the abundance of orchard and other fruits has been found to be greatly influenced by the activity of the honey-bees at the critical time.

Although considerable amounts of honey are produced in and exported from many tropical localities there does not appear to have been carried out those careful studies of the whole question of honey production which are necessary to put this industry on a scientific and stable foundation in such places.

In the United States the results of such studies have been made available, and the publications of the U. S. Department of Agriculture and of some of the experiment stations of the different states are of particular interest in this connection. The U. S. Department of Agriculture has issued *Bulletin No.* 685 entitled "Honey-Bees and Honey Production in the United States" which has been largely drawn on in the preparation of this article. As examples of another line of useful work in this connection mention should be made of *Bulletin No.* 217 of the Agricultural Experiment Station, Berkeley, California, entitled "Honey Plants of California" and *Bulletin No.* 102 of the Texas Agricultural Experiment Station entitled "Texas Honey Plants." As an indication of the importance of honey production some of the figures relating to the exports and imports of honey in the trade of the United States are likely to be of interest.

The exports of domestic honey in the 7 years from 1911 to 1917 (fiscal year ended June 30) ranged from $81,649 in 1911 to $736,139 in 1917, while for 6 months July-December, 1917, the value of such exports was $1,254,887. The value of honey imported into the United States from insular possessions, Hawaii and Porto Rico in 1916-17 was $165,850 and for the second half of 1917 $324,789 and of foreign honey (Mexico, Haiti, Dominican Republic and Cuba) for the same periods was $289,317 and $255,953 respectively.

The total production of honey in the United States is estimated to be considerably in excess of 200,000,000 lb. per annum and if this amount had an average value of ten cents per lb. it would represent a cash value of some $20,000,000.

These figures indicate the very considerable inportance of honey as a marketable product, and also that certain tropical countries are producing large quantities for honey for export. In this connection Jamaica exported in 1918-19 1,175 tons of honey having a value of £154,700 (*Colonial Report*, 1024, Jamaica).

Honey is put on the market in three forms, (1) as section comb honey, (2) as "bulk" or "chunk" honey and (3) as extracted or liquid honey.

Section honey consists of wooden frames or cases of standard size containing the comb, which, when filled with honey by the bees, weighs one pound. These sections taken from the hive are ready for sale and are used to supply a domestic or fancy trade. Chunk honey consists of the comb from the hive frames cut or broken in large pieces and mixed with the liquid honey. The extracted or liquid honey is removed from the comb, ordinarily in a centrifugal machine, or, sometimes, by crushing the comb and draining, although this last method is likely to produce an inferior product. A select form of chunk honey is prepared by cutting suitable sized pieces from choice comb, packing them in glass or tin containers and filling the remaining space in the containers with good extracted honey. A large proportion of the honey has in the past been produced on farms as a minor product or side line and by village and town dwellers. In many instances such beekeepers are well informed and are careful in protecting their bees from losses due to disease and the effects of unfavourable weather conditions. Others have been indifferent or ignorant of the methods to employ. In both cases the product may be sold without due regard to the cost of production, but in the case of commercial bee-keeping, where the profit derived from the results obtained are depended upon as a means of live-lihood, every care must be taken to keep down the cost of production and to sell to the best advantage. In such cases the best of care must be given in every branch of the business. All supplies must be bought or manufactured to the best advantage, the hives must be protected from loss by disease, or cold, or other unfavourable

weather conditions. The sources of nectar supply must be known in order that the bees may as far as possible be encouraged to store the best honey for market as "surplus," that is, in the frames or sections from which the honey for sale is to be taken, while the nectar producing dark or highly flavoured or otherwise poor quality honey is used by them for filling the brood comb.

In the tropics there is no danger to the bees from excessive cold, but the long dry season which is experienced in many tropical localities is often a time of shortage of honey flow. A thorough knowledge of the honey plants which will grow under the local conditions may, however, enable suitable plantings to be made to supplement the indigenous or wild plants which bloom in response to seasonal influences during periods of drought.

In those localities where the honey plants have been studied it has been found that many species of the order Leguminosae are important sources of honey supply. The plants of this order are usually abundant in tropical regions and they will probably be found useful in this connection.

Honey is obtained in the tropics from many palms, the orange, mango, guava, and other fruits, mahogany, logwood and shade and ornamental trees, banana, yucca opuntia and agave and many plants of the flower garden and kitchen garden. A careful study of the honey-yielding trees with notes on the times of flowering and length of flowering period, the colour, aroma, flavour, consistency and the tendency or lack of tendency of the honey to crystallize would be of great benefit to the beekeeper and would be a direct aid to the development on sound lines of a honey producing industry.

The amount of honey produced per hive per annum appears to vary greatly. In some localities and in some seasons this may be as low as 10-20 lb. and in others as high as 40-50 lb.

The losses of bees are due to a few causes which are largely preventible. Foul brood is perhaps the beekeeper's worst enemy, while starvation is also a very frequent cause of loss. The bee-moth or wax-moth is often reported as damaging hives, but it is well known that this insect is not able to cause serious injury to strong, healthy hives. Ants can and do destroy hives. Starvation is the result of a long period of reduced honey flow particularly when the removal of the honey from the hive has left the colony badly provided for.

The price of honey fluctuates as the prices of other commodities do. During the latter part of the war when sugar substitutes were greatly needed, the price of honey went very high at the same time that there was an enormous increase in production and consumption. The prices given for honey in ton lots in November, 1917, in the United States ranged from 10 cents to 20 cents per lb. with an average price for the whole country of 14 cents for extracted, and 17 cents for comb honey.

A note in a recent number of the *Westminster Gazette* states that a British firm which deals largely in honey has bought a large tract of land in the West Indies and established apiaries, the honey from which is shipped in bulk and bottled in England. This allows good honey to be put on the market at a price below that of English produced honey.

The production of honey seems to be worth development in tropical countries. It can be adapted to the conditions of large estates or plantations where it may become a paying side line of industry, and it is also suitable for the small holder or native peasant provided that such people can be taught to use the correct methods and to take the proper care of the hives and of the product from them. The success obtained in comparatively large apiaries in certain localities indicates also that this industry may be a sound proposition on purely commercial lines. Departments of Agriculture which have in the past been helpful in developing minor industries, have a wide field for careful scientific work in the study of honey plants, and in giving advice and assistance to all interested, particularly to those who, without special knowledge of the subject, wish to start in a small way.

H. A. Ballou.

THE EFFECT OF CERTAIN PESTS ON THE COTTON SITUATION.

The American Cotton Annual Review, issued as a commercial supplement to the *Manchester Guardian* gives a review of the cotton situation, and among other aspects of the subject, discusses the influence of some of the important insect pests on the production of cotton and on the prospects for the future.

In the article "Three Dangerous Enemies at Work," Sir Arthur E. Shipley deals with the Mexican bollweevil, the bollworm and the pink bollworm, two of which, the bollweevil and the pink bollworm, are undoubtedly the most serious cotton pests in the world both from the point of view of the reduction of yield per acre and that of the influence on the world's cotton supply.

The Mexican Bollweevil (*Anthonomus grandis*), is an American cotton pest solely. So far it has occurred only in the New World. About 30 years ago it invaded the United States from Mexico, and since that time it has steadily progressed east and north until now the whole of the cotton belt has been invaded.

The pink bollworm has attracted the greatest amount of attention as a pest in Egypt, but it occurs throughout most of the important cotton growing regions of the world except the United States.

The bollworm is cosmopolitan in its distribution, and occurs in most parts of the world within the temperate and tropical regions, but unlike the other two cotton pests just mentioned, the bollworms attack a great variety of plants on which it can subsist and breed.

The bollweevil in America presents the most striking example of the ability of a minute and insignificant looking insect, by exercising its pernicious influence on the greatest staple crop of a great nation, to seriously affect manufacturers and consumers of other countries and indeed the whole world.

It is estimated that in 1902, when the bollweevil had been known to occur in Texas for about 10 years the loss to cotton growers of that State alone was about £2,000,000 for the year, while up to the present time this insect has caused a loss of more than £10,000,000 in Texas.

The cotton growers of the United States have sustained an average annual loss calculated at some £50,000,000, while in 1922 it was estimated to be as high as £80,000,000.

In the face of the work that has been done to prevent this small insect from carrying on its depredations, it has to be admitted that no method of control has yet been devised which approaches completeness. Not only has it been found impossible to eradicate the pest in any locality where it has become established, but all the effort that has been devoted to it has been powerless to prevent its spread throughout the cotton belt. In a space of 30 years the insect spread from southern Texas to the limit of cotton cultivation on the Atlantic seaboard.

Over one thousand delegates representing every interest connected with the cotton trade recently met in New Orleans and organized a National Bollweevil Menace Conference, whose members have pledged themselves to enlist producers, manufacturers and consumers of cotton in the fight against this "billion dollar bug," and the President of the New Orleans Cotton exchange says: "The supremacy of this, the greatest cotton producing country in the world (and our national prosperity "in consequence), is threatened by the ravages of this insect." There is more labour and capital in cotton in the States than in any other commodity. The Director of the National Bollweevil Control Association states: "If we think we cannot "control the weevil we are licked already; for my "part I cannot conceive of a million cotton firms "surrending to an insect. If we don't control "the weevil the nations chief commodity will be "reduced to negligible proportions within a "decade. The world must have a larger supply "of cheaper cotton. If we do not produce it, "other lands will."

No natural enemies have developed to give effective aid in the control of this pest and for many years the ordinary methods of control gave no results of great practical importance. More recently the use of calcium arsenate applied as a dust by means of special dusting machines has proved to be of considerable value. Arsenic enters into the control of insect pests to a very great extent and the demand for it as an insecticide has forced the price from £18 13*s.* 4*d.* per ton in 1916 to £62 in April, 1924. The increase in its use and consequently in its price was largely due to the greater employment of the poison by the American cotton growers against the bollweevil and other pests.

The Bollworm (*Heliothis obsoleta*) is often called the American bollworm, but it is world-wide in its distribution and very catholic in its foods. It occurs in nearly every country where the ordinary agriculture of temperate and tropical regions is possible, and there are but few of the plants which are grown as crops in these regions which this caterpillar will not eat. The bollworm is at times a serious pest of cotton, but it has a variety of other foods and a great number of natural enemies and in consequence it occurs only occasionally in such abundance as to cause noticeable damage.

The pink bollworm (*Platyedra gossypiella*) has assumed a place of first importance among the pests of cotton since its appearance in Egypt in 1910. Previous to that time, this small moth was known to occur in many localities in the East, Asia, Malaya, and Africa, but it was not until it appeared as a serious pest in the cotton fields of Egypt that it commanded world-wide attention. From Egypt it has spread to South America, Mexico and the West Indies. It has made its appearance at several points in the United States, but the present indications are that these sporadic invasions will be entirely eradicated.

In Egypt it is estimated that since this insect became established as a pest of cotton, the money loss to cotton growers as a result of its attacks has been at least £50,000,000.

Since the pink bollworm became established in Egypt control measures have been developed which have probably kept the amount of damage done to a much lower figure than would have been the case if this control had not been enforced.

The bollweevil lays its eggs in the tissue of the cotton boll or in the bud or flower. The larva or grub feeds inside the tissues and the injury causes the bud or boll to drop to the ground. If these fallen bolls are exposed to a strong sun on a dry soil, the larvae or pupae in many of them will be killed, but if the ground is well shaded and damp, they complete their development and reproduce for the next generation. The bollweevil attacks cotton only and the larva is entirely a feeder on the internal tissues of the plant. The adult eats on the surface of leaves and bolls to a small extent and this gives the only chance to poison this insect. The bollweevil hibernates in the adult or weevil state and is very considerably affected by the winter conditions.

The pink bollworm moth lays its eggs on the outside of the plant tissues, and the newly hatched larva has to eat its way into the boll and into the seed where it spends its whole larval life. There is little chance of poisoning this insect by means of arsenicals but it lays itself open to attack in another way. The larva lives and feeds in the seed. It also hibernates and rests in the seed and it is in the seed that this insect has been carried to all parts of the cotton growing world, and in the seed it is carried back to the field each year unless special means of prevention are adopted.

The method of control is by treatment of the seed. Heating the seed to 60°C for a few minutes will result in the death of the pink bollworm in it, and at the same tme this treatment will not affect the germinating power of the seed. Carbon bisulphide is also used for fumigating the seed in order to kill the pink bollworm in it.

These resting larvae may remain in the seed for more than two years and then enter the chrysallis stage, emerge as moths and lay eggs for another generation.

The resting larvae are always inside cotton seed which may be picked with the seed cotton, or in fallen bolls or in dead and deformed bolls left on the plants in the field. It is necessary that every effort should be made to clean up and burn all such seed which does not go to the gins in the seed cotton.

All seed is treated as it comes from the gins and if this work is carefully done (that is, if all fallen seed and seed in bolls on the ground and on the plants is collected and burned and all seed in the ginneries treated every day), a fairly high degree of control of this pest may be maintained. Early maturity of the cotton plant and heavy first bearing are of great importance in dealing with the pink bollworm and also with the bollweevil.

There are many other insects which attack cotton and help to decrease the cotton producer's profits but the bollweevil and the pink bollworm stand out as the great pests of cotton, and so great are they that they interfere with human affairs to an extent almost impossible to calculate.

They interfere with the production of normal amounts of cotton, the bollweevil in the United States and the pink bollworm in all other cotton growing countries in the world. This interference is so great that there is talk of finding substitutes for cotton even in the face of all the great developments of cotton growing in regions where it has not been grown before and of extensions in present cotton-growing areas.

Meantime the cotton production of the world is approaching a crisis. Professor Lefroy, in the American Cotton number (1923) of the *Manchester Guardian Commercial* states that "the pink bollworm . . . is at present a serious menace to cotton production; and the next few years will show whether it be possible to control or whether other fibres must take the place of cotton." Cotton manufacturers in Lancashire are eagerly searching for suitable potential supplies with which to replace the fall in the world's cotton production which is now said to be 16 per cent. below the pre-war average. Manchester obtains approximately 75 to 80 per cent. of her supplies from the United States and about 15 per cent. from Egypt but it is possible that in the near future America will only be able to maintain sufficient supplies for her own cotton mills, while the Egyptian supply has been falling slightly.

The hopes of Manchester are centered upon newer sources of supply and it is certain that present price levels are proving a useful stimulus for the exploitation of new areas. At present supplies from countries other than the United States of America are either so small or so ill adapted for the use of Lancashire cotton mills that little can be hoped for from these sources in the immediate future. It is inevitable that unless the bollweevil can be more effectively controlled or eradicated other fibres will replace cotton at an increasing rate. The figures given above indicate the rapidity with which this pest has established itself and it will require the energetic co-operation of all connected with the cotton industry if man is to triumph over the insignificant looking but perfidious "worm." All such people will therefore welcome the formation of the National Bollweevil Menace Conference for the purpose of "launching a national campaign against the voracious pest."

TEA IN THE EMPIRE.

The growth of the tea industry within the Empire during the past century is an example of agricultural and commercial development so rapid and, on the whole, so sound that it probably equals in importance any similar development on record.

The Empire exhibits at Wembley during the summer now ended have drawn attention to many aspects of colonial industry and prominent among them is the tea industry. In this connection there have appeared a number of articles on the subject in such journals as *Empire Production and Export* (July and September), *Imperial Commerce and Affairs* (July) and in the *Tea and Coffee Trade Journal* (August). These articles have been largely drawn on for the information in this article.

In the July number of this Journal an article on Tea in Jamaica referred briefly to the historical interest of the tea plant and to the development within the Empire of the modern industry and specifically to the success that has attended a commercial attempt to produce tea in Jamaica.

Up to quite recent times tea was produced commercially almost entirely in China and Japan and at the present time in spite of greatly reduced exports, China is probably the premier tea producing country of the world. Statistics are difficult to prepare in a country like China, and particularly for a product which, like tea, enters into the daily use of its enormous population.

China, where tea has been cultivated for a thousand years or more, was originally the only producer and consumer of the products of this plant. In the 13th century, it is said to have been introduced into Japan. About 100 years ago the Dutch established a commercial cultivation of tea in Java. At about the same time the East India Company began to experiment with

tea cultivation in Assam and, in 1836, a pound sample was sent to London. In 1840, tea cultivation was started on a commercial basis in India and a few years later in Ceylon. At the present time, India and Ceylon are the principal producers of tea for export in the world, China Japan, Formosa and the Dutch East Indies, Natal, Nyasaland and other British Colonies following.

India exported 294,700,000 lb. of tea during 1922, and of this 259,100,000 lb. went to England. Ceylon exported in that year 171,400,000 lb. of which 103,900,000 lb. was imported into England. As will be seen from these figures the United Kingdom is the greatest importer of the teas of India and Ceylon ; China, Japan and Formosa teas provide the greater part of the teas consumed in the United States of America.

The tea plant although grown largely in the tropics is apparently a sub-tropical plant. A native of Assam it has spread far from tropical borders in Japan and China and in Natal, and in South Carolina, it has proved its ability to withstand the comparative extremes of the American temperate climate. On the whole, however, the great developments of the tea industry have been well within the tropics, and it would appear that many tropical localities not yet exploited are suitable for tea cultivation. The requirements as to temperature are not exacting, but the hot steamy atmosphere of Assam appears to be very favourable to the production of quantity and quality. Tea thrives on a variety of soils, but the careful selection of the most suitable soils and regard to manurial requirements of the crop will probably yield very satisfactory results both in the matter of quality of product and the health and longevity of the plants. A moderate to heavy rainfall well distributed, something over 70 inches with 200 or more rainy days in the year, is said to be necessary for best results. The one circumstance which would limit tea production in many parts of the Empire is the labour situation. For the successful cultivation, reaping and manufacture of tea an abundant supply of reliable labour is required. Much of the work can be performed by women and children, and is thus eminently suited to many tropical localities, but in such localities the people are often not sufficiently reliable.

The black and green tea come from the same bush, the difference between them being the results of different processes of manufacture.

The rate of consumption of tea varies greatly, the English speaking people using more tea than those of other races. In the United Kingdom the per capita consumption is put at about 9 lb. per annum. Australians and New Zealanders are also great tea drinkers, and they use about as much as the English people. In Canada the consumption is only about 5 lb. per head per annum.

In one day it is stated that two tons of tea were used in serving drinks in the restaurants of the British Empire Exhibition at Wembley.

America is not a great tea-consuming country but intensive advertising may result in increased consumption and by advertising also the British grown teas may be made to replace China and Japan varieties.

The Ceylon tea industry was built on the collapse of the coffee in that colony. During the '70's coffee was so severely ravaged by the Hemelia or bright leaf disease that the planters were faced with ruin. But the success of tea in India induced Ceylon planters to substitute it for their failing coffee with the result that a cultivation of over 500,000 acres has been developed, with a production, which in certain years has gone over 200,000,000 lb.

In Natal, the failure of coffee was followed by a tea development and more recently the tea in this part of South Africa has been to some extent replaced by sugar-cane.

In Nyasaland tea cultivation has passed the experimental stage and in 1922 the imports from this colony into England amounted to 666,560 lb. of tea having a value of £33,080.

In Kenya and Uganda trials are now being made, which give promise of developing into satisfactory commercial propositions. The conditions in Malaya would seem favourable for tea cultivation also.

Information supplied to Kenya by the Director of Agriculture, Ceylon, for the guidance of planters who are making trial of tea cultivation includes the following :—Tea may give a serviceable yield in 3½ to 4 years from planting according to some authorities and in 6 or 7 years according to others. A good yield is 700 to 900 lb. made tea per acre.

In Assam it is estimated that to bring an estate of 400 acres into bearing, to build the necessary factory and other necessary permanent buildings, to purchase and erect the machinery and to import labour would cost from £80 to £100 per acre. In Ceylon, the cost of the machinery alone on an estate of 200 acres all in full bearing is estimated at £1,000 exclusive of power engines and buildings. Virgin soil is advised for planting tea but many tea gardens have been established on old coffee or flax lands.

The cultivation of tea would appear to be attractive to planters who need to find a new crop in localities where the climate and labour conditions are right for such a development. In the older tea districts where labourers are liable to become disaffected and seek higher pay, the expansion of the industry is likely to be at a much slower rate and in this, and in the prospect of greatly increased consumption in the future lies the safeguard of the planters who are minded to try it.

H. A. B.

TROPICAL WORLD.

MAURITIUS.

In a résumé of the first part of the Annual Report of the Director of Agriculture of Mauritius for the year 1923 (published in *La Revue Agricole de l' Ile de Maurice*, No. 16) it is stated that the production of sugar for 1923 was about 17 per cent. below the average. Unfavourable climatic conditions have especially affected the small Indian cultivators whose methods of culture leave much to be desired. During the year under review two of the smallest factories closed down. This leaves a total of 50 factories working in the Colony. No changes in the equipment of the factories were made but new manufacturing processes were tried on a fairly large scale, among others, the Bach process and the use of phosphoric acid. Sulfitation was tried with success, Philippe filters are at last being appreciated and experiments with the Petree process are being continued.

The acreage under sugar-cane at the end of 1922 was 6,000 arpents (1 arpent = 1½ acres) less than in 1921. This consists principally of lands economically unsuited for growing canes but cultivated because of the high prices obtaining in 1919 and 1920. The drop in the price of sugar for 1921-22 automatically readjusted things. Practically all available cane lands are under cultivation but possibly more economic means of transport and the extension of irrigation would open up new areas for cultivation.

Tobacco cultivation is being encouraged. With the system of giving permits for tobacco cultivation on the condition that the leaves should be sold to the Government the industry has received a new impetus. The tobacco industry can be considerably developed in Mauritius and Dr. Tempany considers it one of the secondary industries of Mauritius with the best outlook.

CHILI.

In *The Chamber of Commerce Journal*, Vol. XLVIII, No. 557, it is stated that despite the favourable anticipation for a general all-round increase in the prospective yield of agricultural crops, the severe drought experienced in the north and centre of Chili—it has rained twice only in Santiago during the whole of the rainy season—has caused much loss to agriculturists in the districts affected. On the other hand, in the south of the country, the rainfall has been exceptionally severe, but in this case the consequent damage to crops has been very slight. The decrease in the anticipated high yield is reported to be so big that the Government is contemplating putting an embargo on the export of cereals. Whether this contemplated embargo is an actual necessity or not remains to be seen, because the Government, having announced their intention of thus restricting exports, have made no move to introduce the measure to either House of Congress; and it is not improbable that the proposed measure is merely a move to check speculation, and to prevent, if possible, the undoubted rise in prices of agricultural products for home consumption were there to be a shortage with an unrestricted export. The whole situation is in a state of flux, especially as the drought may break any day, and thus, to some extent, ease the situation.

PANAMA.

The Institute of Research in Tropical America, co-operating with the division of biology and agriculture of the National Research Council, has developed the biological station on Barro Colorado Island on Gatun Lake, Panama Canal, which according to a note in *Science* by D. Vernon Kellogg, the permanent secretary, was ready to accommodate scientific men for research work during the summer just past.

Barro Colorado is an island formed by the top of one of the mountains rising above the valley of the Chagres River. The rising waters of the Gatun Lake have isolated this hill top with its five square miles of tropical jungle and native fauna. A note by Mr. W. C. Allee in *Science* June 13, gives a brief description of the existing conditions. Comfortable living quarters and laboratory accommodation make it possible to live on the island and carry on biological studies. The jungle, of the rain forest type, receiving one hundred inches of rainfall per annum, is dense over the whole area, the jungle roof in general is about one hundred feet up with scattered trees overtopping it. There are remnants of plantings of bananas, oranges, limes, guava, &c., but these are all abandoned and the general character over most of the island is that of virgin forest. Insects are most abundantly represented by ants and termites. Peripatus is also found. Birds are most noticeable of the higher animals, with lizards a close second. Mammals are represented by a wide range of species. This station will be of special value to American research workers on account of its accessibility, the Panama Canal being readily reached from New York and San Francisco and the island being within easy distance from Panama City. Several scientific workers were expected to visit this station during the summer. The introduction to the tropics which can be obtained in this way will be of value in stimulating interest in the tropics on the part of biologists of temperate climates. Assistance is given to investigators in the matter of certain commissary privileges, and in connection with passages from San Francisco and New York. Information regarding the Station and the conditions under which scientific workers are received there, may be had from Mr. Jas. Zetck, Ancon, Canal Zone, or Dr. Thos. Barbour, Museum of Comparative Zoology, Harvard University Cambridge, Mass.

BRAZIL.

The International Review of Science and Practice of Agriculture (Vol. II, No. 1) gives an interesting account of the report made by C. Lohamann to the Minister of Agriculture on his travels in the State of

Sao Paulo for the purpose of studying the cultivation and preparation of tea. Tea-growing in this State dates from the beginning of last century, the seed used having probably come from the Rio Janeiro Botanic Gardens. In 1852, the total production of the State was nearly 30,000 kg., *viz.*: about one-tenth of the present consumption, and there were already 30 agricultural tea factories in various municipalities (Itu, Capivary, Piracicaba, Porto Felix, Sao Roque, &c.). Afterwards tea production decreased owing to some extent to the preference shown for coffee and to the abolition of slavery, but chiefly on account of the poor quality of the product which was much inferior to Assam tea. Since there is no doubt that the country is suitable for tea cultivation (which would be more profitable than coffee-growing), all that is necessary is to use selected seed from the best centres of production. The whole district, from Mogy das Cruzes to Sao Rogue and from Paruhyba to Jundiahym, which is almost useless for coffee, would be very suitable for tea. The chief centre of production at present is Murumby, but the crops now amount to barely one-fifth of those in the middle of last century. In many places, there are still plants growing in the old tea-gardens which shows how well they have become acclimatised.

We learn from the *Louisiana Planter* that the coconut industry in Brazil is gaining considerable ground. A recent report shows that 30,860 hectares are given over to the raising of the nuts, not to speak of the scattered untabulated areas in various parts of the country. Bahia is credited with the largest area, namely 11,550 hectares. In Pernambuco, where there are 5,101 hectares they have a number of factories to work up the coconuts.

QUEENSLAND.

From *The Australian Sugar Journal* Vol. XVI, No. 6, we learn that the Innisfail and District Fruit Growers' Association are taking up the question of banana growing with considerable enthusiasm, and it was stated in a recent report appearing in the *Johnstone River Advocate* that nearly 60,000 banana suckers had been applied for. Inquiries are being made concerning railage and fruit trains. The Producers' Association and several prominent fruit growers in Central Queensland are being written to, seeking information as to the best means for securing supplies of suckers guaranteed free from disease.

The speech of His Excellency the Governor (Right Hon. Sir Matthew Nathan, P.C. (Ire.), G.C.M.G.) at the opening of the Second Session of the Twenty-third Queensland Parliament on 29th July, reported in the *Queensland Agricultural Journal*, Vol. XXII, Part II, contained the following references to the State's agricultural progress and problems :—

During the year, production in the sugar industry was greater in the northern area than ever previously recorded, though south of Townsville the crushing was below the estimate. The tribunal appointed under the arrangement with the Commonwealth Government has fixed the price of raw sugar for the current season at £27 per ton, but the Sugar Pool Board will not be able to pay the full price of £27 per ton to the millers owing to the loss which it is anticipated in finding an export market for the surplus production. As the present arrangement between the Federal and State Governments in respect of the marketing of the sugar crop will expire in 1925, some anxiety exists as to the policy of the Commonwealth Government for the future.

The cotton industry continues to advance despite the dry weather and numerous insect pests, although owing to these causes, the yield per acre in many districts was not as good as might be wished. The harvesting season for seed cotton has been extended to meet the conditions of the season. The total yield is expected to reach 15,000,000 lb. of seed cotton. The outbreak of the pink boll-worm, which has been so destructive to cotton crops in other parts of the world, emphasizes the wisdom of passing special legislation to insure the whole of the cotton stalks and debris being destroyed every year, and to provide a close season. Special precautions have been taken in the field and also to insure the effective treatment of seed prior to its being planted. The necessary apparatus has been installed for this purpose. The Commonwealth Government have imposed most rigid conditions regarding the importation of cotton seed.

LIBERIA.

The rumour that the Firestone Rubber Tyre Company has secured a concession of 1,000,000 acres of land in Liberia makes that African republic of instant interest. It is estimated that of the 43,000 square miles belonging to Liberia at least 20,000 square miles are rubber forest that has hardly as yet been touched. Sir Harry H. Johnston, once special Commissioner in Uganda, stated in 1905 that Liberia had four times as much rubber territory as had Uganda. As the last-named country averaged for years 2,000 tons annually of wild rubber, Liberia's possibilities are great.

As a region favourable to Hevea planting, it is fully equal to any part of Brazil, the Federated Malay States, or Sumatra. The soil is rich, the climate strictly tropical, the rainfall over 100 inches, and the region free from destructive storms.

The native blacks number over 2,000,000 and the civilised negroes, who are in control, some 60,000. The country is advised and to a degree financed by the United States, France and England. Taxes are light and capital is protected. There is also plenty of cheap labour. It should also be remembered that there are existing Hevea plantations there, doubtless enough for an abundant seed supply.—*The India Rubber World* (Vol. LXXI, No. 1.)

THE PHOSPHATE REQUIREMENTS OF SUGAR-CANE.[1]

For some years past an exhaustive series of experiments on the phosphatic manuring of sugar-cane has been carried out at the Experiment Station of the Hawaiian Sugar Planters' Association by W. T. McGeorge. Th result of this work, although they apply especially to Hawaiian soils, are of interest to cane planters in general.

The sugar-cane crop of the Hawaiian Islands is confined to the lowland sections skirting the coast. Cropping is continuous, and fallowing or rotation rarely practised, so the soil is never at rest. Wide variation occurs in yield per acre in different sections of the islands, and even on the same plantation. This variation, it should be noted, is due mainly to environment, temperature, exposure and moisture supply. Variation in mineral nutrients present in the soil is only a minor factor in comparison. On the other hand, field experiments have shown definite areas in which deficiency of phosphate is a limiting factor to crop yield.

Many of these areas were found to contain relatively large amounts of phosphate, but little of this is in a condition in which it can be taken up by the plant, that is, little is present in an available form. Because of this low availability it has been the general practice to include phosphates among the fertilisers applied. Even where this has been done, only a small percentage of the soils show a profitable return. Unnecessary expense of this kind may be eliminated by determining :—

(*a*) the conditions which affect the availability of soil phosphates. Knowledge of these should enable the amount of available phosphate to be increased at the expense of the total phosphate present.

(*b*) the amount of available phosphate in the soil necessary for satisfactory crop yield. If insufficient available phosphate is present, addition of a phosphate fertiliser should give profitable response. If more than sufficient is present the response will be inadequate in view of the expense incurred.

McGeorge has found that the acidity of the soil and its lime content are the principal factors involved in the availability of phosphates and their assimilation by the cane. The soils in which the phosphoric acid is of low availability are high in acidity, and those in which the availability is high are low in acidity or alkaline. There is, in fact, a close relationship between the availability of phosphates and the soluble lime content of the soil. There appears also to be a close relationship between the degree of decomposition of the soil silicates and the availability of the phosphates. The more decomposed the soil silicates, that is, the more easily soluble the silica present in the soil, the greater the availability of the phosphate and the greater the assimilation of the phosphate by the cane.

The determination of that portion of the soil phosphates which is available to plants is no easy matter. Little is known about the state in which phosphate compounds occur in the soil and no definite line of distinction can be drawn between those which are, and are not, available. Much depends on the conditions to which the various compounds are subjected, no definite group of phosphates being necessarily available before any other group becomes so. Under any definite set of conditions empirical methods of determining the available phosphates can be deduced, by comparing the results of chemical analysis with those of field experiments. This method has been much used in the past, but has fallen into discredit because of attempts to apply the results too generally, for example, to widely different crops grown under different conditions. In such cases as the sugar industry of Hawaii, where it is necessary to deal with only one crop, and where one is concerned with only such variation of feeding power as may exist with different varieties of cane, correlation of chemical analyses with crop yields can give useful results.

At the Hawaiian Experiment Station a large number of methods of determining the available soil phosphates has been tested. The one found most suitable to the existing conditions involved the extraction of phosphate from the soil by means of 1 per cent. citric acid. The results obtained have been checked in the field and serve as an indication of the phosphate requirements of the soil. They may be summarised as follows :—

A soil when planted with sugar-cane responds to phosphate manuring, with rare exceptions, when it contains 0·0025 per cent. phosphate (as P_2O_5), or less, soluble in 1 per cent. citric acid, if :—

(*a*) it has a fairly high acidity,

(*b*) its lime content is present in a difficultly soluble form,

(*c*) it has a low content of soluble silica.

It would be good to apply phosphate continuously to such soils until the acidity is permanently reduced to neutrality by lime applications.

If the soil contains 0·0025 per cent. to 0·004 per cent. of available phosphate it is better to rely on field experiments than on soil analyses to determine whether phosphate manuring is necessary.

If the soil contains more than 0·004 per cent. P_2O_5 soluble in 1 per cent. citric acid, it will not respond to phosphate additions, even if it is strongly acid.

These results are being extensively applied to those Hawaiian soils on which sugar-cane is grown as a guide to phosphate requirements.

P. E. T.

1. Mc George. Bul. 45, Agricultural and Chemical Series, Experiment Station of the Hawaiian Sugar Planters Association.

TECHNICAL CONTROL IN AGRICULTURE.

DR. H. M. LEAKE, M.A., SC.D. (CANTAB.), F.L.S.

Let me draw a contrast. I well remember a conversation some twenty-five years or more ago when the advantage of the employment of a works chemist in a cement works was under discussion. The owner was opposed to the suggestion and his argument was, briefly, as follows: by the time the chemist had completed his analysis of the clay and chalk which went to the composition of the cement, these two had been mixed and appeared as the final product. That was, as I have said, some twenty-five to thirty years ago and expressed the then too common attitude of the producer to technical control. I now turn to the other picture. A short time ago a well known planter was visiting the Imperial College. In the course of discussion the question of the employment of technical control on sugar estates arose and he expressed himself somewhat on these lines; I give my chemist good pay, free hours, electric light and all I can towards his comfort and he is still the cheapest man in my employ. That expresses the practical view held at the present time by the vast majority of producers employing technical processes and the contrast is very marked. But even in the latter case it is doubtful whether in the balance-sheet full credit is given to the value of the body of workers of whom, in the above cases, the technical chemist is the representative. In the last twenty-five years great changes have come over the cement industry; the open vats and simple kiln have been replaced by the rotary kiln, and these changes are the joint work of the research chemist and the engineer. In the case of sugar the substitution of the muscovado process with its open pan by the central factory with its triple effect is the result of the skill of the engineer and of chemical research on the constitutents of the juice and on the inversion changes which take place during boiling. On the cultivation side again, the technical chemist financially justifies his existence by control of the manure supplies but in the balance sheet no credit is given to those large numbers of workers by whose study the principles and the systems of manuring have been worked out.

I have, however, digressed for I am not at the moment concerned to justify the research worker. My aim is to draw attention to the change in attitude towards the technical worker in industrial processes and to compare this with agricultural development in the same direction. For while this change has taken place in the industrial world but little development is to be noticed on the agricultural side. As a body the planter or farmer keeps a simple system of accounts and neglects the systems of costing employed by the manufacturer. The work of Orwin and the Agricultural Costings Committee had no marked influence and few practical farmers accurately cost out the value of any new practice.

This defect affects even more fundamental issues than the industrial processes to which I have made reference, for it refers to office organization and systems of book-keeping, branches of the manufacturing organization the importance of which has long been recognized in the industrial world. And if such defects are found at this stage of agricultural organization it is hardly surprising that the value of technical control in agriculture has generally been missed, for the recognition of values is in such cases very largely a matter of accurate costing.

What then, is the substance of technical control in agriculture? This must depend in large measure on the type of cultivation employed. It will take one form in the case of plantations growing tea, rubber, cocoa and the like which are perennial orchard crops; it will take another form in the case of mixed farming with short season crops as sugar, cotton, oilseed and so on. It will take one form if the land is owned directly and worked by paid labour, it will take another if the land is leased and worked on a tenancy basis. In the former cases it takes the form of actual skill in the practical handling of the land and of the stock and crops which the land carries; in the latter cases this aspect is not so important and technical skill will be re-inforced by a knowledge of the relationship between landlord and tenant, of the organization of credit and co-operation and of the best markets for buying and selling.

The importance of technical control as it applies to the plantation is fairly generally recognized though much remains to be done to introduce into practice the results of recent research. When, however, we turn to the question of estate management and tenancy, technical control is mainly conspicuous by its absence. One of the main difficulties of small holdings, whether held directly or under lease, lies in the provision of capital. With a correct relationship between landlord and tenant the latter should look to the former to supply his needs in this respect. The subject of the relationship between these two is one that still offers a large field for investigation but, though the main principles are known, they are rarely adopted in practice.

Before such control can be exercised it is necessary to train men in the principles. Tropical development will be based largely on a tenancy system and the rapid progress now being made in the opening up of tropical areas demands men and trained men, if the correct relationship between the foreign agent of development and the indigenous tiller of the soil is to be established. Even established estates working on a tenancy basis will derive benefit from control of this nature. It is in this matter that the Imperial College can do good work. By working an estate with a system of tenancy and by a study of this relationship, both practical and theoretical, instruction will be rendered available for the

training of the body of men now needed. Just as the recognition of the need of technical control in industry was slow in coming, so the recognition of this need, as I have defined it, for agriculture, may be slow to develop, but I look forward to a time when the owners of estates will be making of such managers the same observations as were recently made of the chemist by the planter to whom I have made reference above.

A PHYSIOLOGICAL ASPECT OF FRUIT-PRODUCTION

To *Science Progress* No. 73, Dr. R. C. Knight contributes a useful summary of recent researches on the carbohydrate/nitrogen ratio of plants. As he points out in his introduction, there is between plant physiology and horticultural practice a gap which has only been bridged at a few points, such operations as pruning and manuring being carried out by rule-of-thumb methods largely dictated by tradition.

The usefulness of scientific enquiry into the reasons for, and the results of, horticultural operations is obvious, and this recent work of American physiologists on the carbohydrate/nitrogen ratio is a good example of such enquiry.

It has long been recognised that heavy nitrogen manuring may lead to strong vegetative growth, and the whole practice of pruning rests upon recognition of the fact that fruitfulness may be affected by interference with vegetative growth.

Kraus and Kraybill (in a paper on "Vegetation and Reproduction with Special Reference to the Tomato" *Oregon Agric. Coll. Exp. Sta. Bull.* 149, 1918) first put forward the theory that the relation between the vegetative and reproductive growth made by a plant is determined by the relation between the amounts of carbohydrates and of nitrogenous substances available within it. It is not, of course, held that this is the only determining factor in fruitfulness—the hereditary constitution of the plant must certainly be taken into account, and other conditions will play their part, but the important point of the theory is, that other conditions being at their best, maximum fruitfulness will depend on the attainment of the correct balance between these two classes of nutrients.

The close relationship of this theory to horticultural practice is evident when we consider that the nitrogen supply of the cultivated plant can be controlled by suitable manuring. The carbohydrate supply is manufactured in the green parts of the plants, chiefly in the leaves, and is therefore affected by any change in the activity of the foliage; for instance, defoliation of a tree reduces the carbohydrate supply at once. Winter pruning in temperate climates removes a certain amount of carbohydrate material stored in the stems, whilst summer pruning (and pruning of tropical orchard crops, which are in leaf practically throughout the year) removes a certain amount of stored materials as well as a certain proportion of the manufacturing surface.

Since the publication of this theory several workers have applied it in investigations on various plants. In particular the apple tree has been studied from this point of view. In the apple the fruit is borne on specialised branches, or "spurs," which form their fruit-buds in one year and develop the flowers and fruit in the next. Hooker ("Seasonal Changes in the Chemical Composition of Apple Spurs" *Univ. of Missouri Agric. Expt. Station Bull.* 40. 1920) analysed spurs at intervals over the two years' cycle and found that the ratio varied considerably, being low when vegetative growth was going on, which is what would be expected, since low ratio implies relatively high nitrogen. As growth ceased at the end of the season accumulation of carbohydrates formed in the mature leaves sent the ratio up, and this was the period at which the fruit-buds were laid down; in the next year it fell again as flowering depleted the carbohydrates first.

Hooker also made field trials of the effect of nitrogenous manures (*Univ. Miss. Agric. Expt. Sta. Bull.* 50. 1922) and found that addition of nitrogen to the soil in spring increased the nitrogen in the spurs at the time of fruit-setting, and that the set was increased in consequence.

Harvey and Murneek (*Oregon Agric. Coll. Expt. Sta. Bull.* 176. 1921) also worked on apple spurs, and altered the ratio by defoliation. The results were in accordance with the theory.

Several more papers bearing on the question are cited by Knight, and it may be well to quote his warning—"Further investigations along such lines appear to be promising, but the inevitable first effect of progress has been to demonstrate the complexity of the problem." Complications arise in that the ratio differs, as might be expected for different plants; that conditions accompanying fruit setting are different from those favouring fruit-bud formation; that the region in which changes in the ratio are important has yet to be located. "Again," to quote verbatim "there is the question of cumulative and reciprocal influences. The excessive vegetative growth induced by a low carbohydrate/nitrogen ratio must react upon the ratio by virtue of the increased assimilating area. In such a case as the apple, it may be deduced from the work of Hooker and of Harvey and Murneek that such factors as the length of the growing season, as influenced by weather, will also be a factor of importance. Finally, it may be necessary in many cases to consider not only accumulated reserves, but also the relative rates of nitrogen absorption and of carbohydrate synthesis at critcial periods of growth."

Nevertheless, a very definite advance has been made in our knowledge of the physiology of fruit-bearing. The possible application of the theory to tropical crops will be considered more fully in a future issue of this Journal.

E. E. C.

VEGETABLE FAT PRODUCTION AND THE CALCIUM CONTENT OF SOIL.

PROFESSOR F. HARDY, M.A.

1. *Formation of fats by plants.*

The precise manner in which plants manufacture fats or fatty oils is by no means clear, but sufficient evidence has now been accumulated to indicate that vegetable fats arise from carbohydrates, such as sugars and starch, and that the seat of their formation is the cells of actively growing regions or meristems (1). In green assimilating tissues, for instance, fats are always present; the growing points of roots are frequently very rich in fat, and freshly cut surfaces of starchy storage organs, such as the potato tuber, rapidly acquire, on mere exposure to air, a continuous protecting layer of fatty substance called suberin (2).

2. *The Chemistry of fats.*

Fats are compounds of fatty acids and glycerol, into which they may readily be split by a process known as hydrolysis. The soap manufacturer accomplishes this result by boiling fat with caustic soda solution. A sodium salt of the fatty acid (which is hard soap) is thereby produced, and glycerol is liberated. Whereas fats and fatty acids are insoluble substances, sodium soaps (as well as potassium soaps and magnesium soaps) are quite soluble in water. Calcium soaps, however, are insoluble. In the living plant, hydrolysis is readily accomplished at ordinary temperature through the agency of enzymes called lipases. The resulting fatty acids, in this case, may form *soluble* sodium, potassium or magnesium soaps, or they may form *insoluble* calcium soaps, by interacting with the different salts present in the cell sap. Consequently, the composition of the cell sap mainly decides the relative amounts of soluble soaps and of insoluble calcium soap that may thus be produced. Furthermore, because the composition of plant cell sap is partly decided by the composition of the soil, it is at once evident that there must exist some close connection between the processes of fat transformation in the plant, and the composition of the soil.

3. *Utilization of fats by the plant.*

The fat manufactured in plant meristems may accumulate there, or may be transported in some way to special storage organs, or to peripheral regions where it is changed by oxidation into insoluble, varnish-like water proof material, which comprises the cuticular layers covering the outer surfaces of stems and leaves. It would be best to consider these cases separately.

(*a*) *The plant cuticle.*

During tissue differentiation, fats first arising in the protoplasmic contents of apical meristems, appear to migrate to the cell wall. Here they are deposited and held to in extent depending mainly on the ratio of calcium to sodium, potassium and magnesium in the salts supplied by the soil. If these salts contain abundant calcium, the fatty substances are completely deposited and firmly retained at the cell membrane. If, on the other hand, calcium is deficient or absent, and sodium, potassium and magnesium is plentiful, the fatty substances freely diffuse as soluble soaps, and may eventually reach the outer surface of the plant, eventually to be oxidized to cutin (1). Probably, for this reason, plants growing upon lime-free sour peat possess thick fatty cuticles (3), but "become disorganized when grown on soils containing abundant calcium, as a result of the choking of the tissue immediately behind the meristem, through the accumulation of insoluble calcium soaps" (4). In a recent paper on the plant cuticle, J. H. Priestley and B. Lee (5) have adduced evidence to prove that external conditions, as regards the composition of available nutrient salts, play a large part in determining the nature and extent of fatty cuticular deposits. In particular, they have demonstrated that potash manuring produced greater mobility of fats in the leafy shoots of certain fruit bushes, and therefore increased the thickness of the cuticle. Liming, on the contrary, diminished fat mobility and resulted in a thinner protecting cuticle.

These conclusions may have great significance in connection with drought resistance, for plants possessing thick cuticles are best able to withstand desiccation. Other things being equal, therefore, plants growing on non-calcareous soil should be more drought resistant than plants of the same variety growing on calcareous soil. It ought to be possible to test this reasoning for tropical crops such as cotton and sugar cane, which are frequently raised under conditions where their water relations are the limiting factor for successful growth.

(*b*) *Fat Reserves of plants.*

In certain plants, abundant fat is stored in the tissues of seeds or fruits. Many of these (for example, castor oil seeds), contain as much as 60 per cent. of their dry weight of fat. It is generally conceded that fat is mainly formed *in situ* in the growing meristematic tissues of the storage organ from materials in the immediate neighbourhood, rather than from translocated hydrolysed products of fat initially produced in other regions (6). Occasionally, however, fat may be transported as a fine emulsion to the organs of storage, its passage through the cell walls probably being facilitated by the intermediate formation of soluble soaps (6). In any case, it is reasonable to suppose that the composition of the cell sap, as regards its content of potassium, sodium, magnesium and calcium, may control in some measure the actual course of the chemical changes involved in the laying down of fat reserves, as well as the total amount of fat produced. Hence we should expect that fat production may at least be influenced by the composition of the soil, and by its manurial treatment.

4. *The effect of soil composition on fat production.*

Certain field experiments appear to bear out this conclusion. Thus, C. R. Fellers (7), of the New Jersey Agricultural Experiment Station, found that applications of lime to the soil markedly decreased the oil content of soybeans in proportion

to the amount of lime applied. This result has very recently been completely confirmed by R. W. Stark (8) at Urbana, Illinois. Stark also found, however, that liming concurrently increased both the total crop yield and the protein content fo soybeans, a result which supports a similar conclusion previously recorded by J. G. Lipman and A. W. Blair (9), but which may perhaps be ascribed to the beneficial effect of lime on those soil conditions that favour the activity of nodule-forming bacteria. Hence, although liming decreases the percentage of oil in soybeans, the total production of oil per acre may actually be increased by liming.

Most sour or acid soils owe this condition to calcium deficiency, and, provided the degree of acidity is not so great as to impair fertility, such soils should induce a relatively high fat production in oleaginous plants growing in them. That soil acidity and oil content are directly correlated is indicated by statistics for the soybean crop in Illinois (8), but, as far as, the writer has been able to ascertain by correspondence, no such relevant data have as yet been accumulated for the oil palm (Nigeria, Sumatra), nor for the coconut palm (Honduras). It is known, however, that edible nut-bearing trees thrive best on particular soil types. Thus the pecan (*Carya illinoensis*) is successfully grown as an orchard crop on the soils of the coastal plain of Georgia, Florida and Alabama (10), which appear to be well suited to the production of high quality nuts. These soils are acidic in nature, possessing "lime requirements" that vary from about 600 to 1,200 lb. of lime per acre (11).

There is need of further investigations into the relationship between fat production and soil composition, particularly in respect to calcium content and degree of acidity. Some aspects the problem are being considered at the Imperial College of Tropical Agriculture where critical experiments with the cotton plant, cacao, castor oil and linseed are now being planned. The results should have considerable bearing on the vegetable oil industry.

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RUBBER OUTLOOK IN MALAYA

At a general meeting of the Central Perak Planters' Association held at Ipoh, Allan E. Moreira editor of the *Times of Malaya* and of the *Malayan Tin and Rubber Journal*, delivered an address on the agricultural outlook in Malaya.

Mr. Moreira sketched the condition of the rubber industry as it developed from 1918 and of the influence of world events on its progress. Coming to the introduction of compulsory restriction he stated that while the remedy was effective enough when it was first applied, the situation had changed, and, due to the folly of extending plantings both in Malaya and in the Dutch Indies, the industry was again heading for another crisis.

The immature areas in Malaya and the Dutch Colonies and their potential production he considered a real danger. In Malaya alone there are more than 900,000 acres still to come into bearing. The extensions of planted areas in the Federated Malay States had been great since 1916, probably greater Mr. Moreira thought, since the Rubber Industries' Protection Committee, which was appointed in 1918, issued its grave warning that the production of 1918 and 1919 would be sufficient to meet consumption in 1918, 1919 and 1920, without touching the 1920 crops. European estates had increased by 46 per cent., Asiatic estates of over 100 acres by 91 per cent., estates of less than 100 acres by 59 per cent., and small holdings by 64 per cent.

The immature rubber acreage of Java and Sumatra appeared to be some 300,000 acres.

Mr. Moreira was of opinion that no further planting should be permitted. This point had not yet been authoritatively pronounced upon, but nevertheless it was of the most urgent and vital importance. He thought the present acreage

sufficient ; further planting should be devoted to new crops such as oil palm, coffee, roselle and other fibre, kopak, &c., all of which were receiving very little attention in Malaya. If one tithe of the present efforts expended on rubber restriction were diverted to new crops, Malaya would be able to face the future with some measure of equanimity.

A SUBSIDY FOR BEET SUGAR.

The Government's proposals in respect of the sugar beet industry, as recently announced by the Chancellor of the Exchequer, are briefly as follows :—A direct subsidy will be given from the Exchequer on sugar produced from home-grown beet, to the amount of 19*s*. 6*d*. per cwt. for four years, including the present year, then 13*s*. per cwt. for three years, and 6*s*. 6*d*. per cwt. for a further three years. The Excise duty, from which the home producer is at present exempt, will be reimposed. The net effect of these proposals will be to give the home sugar industry a total advantage of 21*s*. 5*d*. over foreign imported sugars, instead of 11*s*. 8*d*., as at present ; an advantage which can be very little affected by any further reduction in the sugar duty. The industry will now know exactly what it will receive by way of State assistance over the whole period of ten years, and, with the removal of any uncertainty as to the future, the factor which has, up to the present, been largely responsible for retarding the development of the industry, will disappear.

The Government considers that, with this assistance, the manufacturers should be able to pay the farmer during the first four years of the subsidy period not less than 44*s*. a ton for beet of 15½ per cent. sugar content delivered to a factory, and this condition will be attached to the subsidy. In actual fact it should be possible with sugar at its present price for a good grower to earn at least 50*s*. a ton for his beet under the contract system which is in force at existing factories, and he would benefit by any rise in the price of sugar. With a fixed minimum price the farmer will be insured against a serious fall in the price of sugar, and the inepxerienced grower will be able to reckon on a sufficient return during the period in which he is learning how to increase his yield and improve the quality of his crop.

(*Journal of the Ministry of Agriculture*. Vol. 31. No. 6.)

REPORT ON PINEAPPLES AND BANANAS IN JAMAICA.

The pineapple crop has suffered from the severe drought experienced. The Director of Agriculture reports that the "China" or "Sugar-loaf Pine," grown in the St. Andrew district, is the most profitable variety to cultivate. £65 was received for the fruit from about one acre this season, and the whole experimental area of two acres is now in full cultivation and looks promising for next year.

The cultivation of bananas has been considerably extended and improved ; the acreage under cultivation being more than four times greater than ever before. In places where land was available, and good or fair results from experimental plots showed that extension was likely to be successful, the increase has been considerable—increasing in some instances from 10 acres to 100 acres on the larger properties. One factor that contributed largely to the increased interest taken in bananas was the introduction, towards the middle of the year, of a banana Fields Competition, to which several fruit companies generously subscribed money for prizes.

CORRECTION.

In an article on Artificial Farmyard Manure by F. Hardy, published in our issue of September (Vol. 1, No. 9.) a footnote on page 133 stated that it is *presumed* that Adco mixture is composed of certain ingredients. It is clearly to be understood that this statement is entirely a supposition, for the exact nature of Adco mixture is entirely unknown to the writer.

On page 174 of the last issue of this Journal (Vol. 1., No. 11) in the note on "Sugar-Cane Experiments at Ste. Madeleine, Column 1. fourth line from the bottom, instead of "60 lb. N" read "80 lb., N.," and Column 2, first line instead of "60 lb., N." read "80 lb. N."

COLLEGE NEWS.

On October 31st, His Excellency the Acting Governor visited the College and devoted some time to an inspection of the Sugar Factory.

The Principal, accompanied by his wife and son, returned from Barbados by the S.S. *Ingoma*.

Two students from Glasgow, one from Oxford and one from Cambridge, have arrived in Trinidad to take a Post Graduate course at the College.

Mr. R. Snow, B.A., Research Fellow of Magdalen College, Oxford, has just published in "Proceedings of the Royal Society," B. Vol. 96, the results of work done at the Imperial College of Tropical Agriculture from December, 1923 to February, 1924, on "Conduction of Excitation in Stem and Leaf of Mimosa Pudica." Several new facts are added by this contribution to our knowledge of the interesting behaviour of the Sensitive Plant, and earlier work on other species has been confirmed.

Subscribers to the College Journal have been increasing steadily month by month and the Journal is now circulated in 88 different countries. Enquiries are constantly being received concerning back numbers. The January, July and September issues (Vol. 1. Nos. 1, 7 and 9), are exhausted and out of print, but a limited number of the other issues at the published price of 6*d*. per copy can still be obtained on application to the Editor, Imperial College of Tropical Agriculture, St. Augustine, Trinidad.

The Editor is prepared to repurchase a limited number of copies of Vol. 1, Nos. 1, 7 and 9 at 1*s*. per copy, and any reader possessing spare copies of these numbers is requested to communicate with him.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observatons is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—The report that the world production of sugar amounts to 21,250,000 tons as compared with 19,500,000 tons last year would appear to indicate a fall in price, but futures are firm, and the market seems confident that the increased production is not at all above the total wants ahead. The spot market for sugar has been a little in buyers' favour and New York reports that on October 31st the raw sugar market was easier and prices declined to $5.90 for Cubans duty paid.

COTTON.—Prices have gone to further high levels touching 15·20*d*. per lb. spot on October 6th (Liverpool), for middling American. Some reaction was shown after that date but the fear of a bullish Bureau report held against much decline.

CACAO.—West Indian cacao is again dearer having risen to 16*c*. per lb. in New York on October 31st, and to 79*s*. to 81*s*. in London on October 27th. The West African cacao, "fairly fermented," rises year by year in mean level of quality and constitutes one of the most promising features of Empire trade.

COFFEE.—The upward rise in coffee has continued and sales show an increase. Mysore middling rose to 142*s*. per cwt. in London on October 8th. Ordinary Santos remained firm at 108*s*. per cwt.

TEA.—Prices in London for tea continued high and the demand remained strong. Averages on October 8th had risen to 23·72*d*. for Ceylon and 22·98*d*. for Indian and declined to 18·67*d*. for Java.

SISAL AND HEMP.—The supply of hemp from the Philippines continues much below needs, though the new crop is apparently a good one. Prices remain unsettled. Prime Sisal reached £51 a ton in London on October 8th and Manila hemp continued to rise and reached £59 a ton.

RICE.—Rice continued not to advance with the general rise in other cereals and Burmese ordinary at 17*s*. per cwt. is a very steady market.

COPRA.—Prices for copra now include £32 for best Malabar, and £30 for ordinary East Indian. Between these points a number of others are quoted and available.

OILCAKE.—Sales of oil cake are rather good and include linseed cake at 14*s*., cotton seed at 9*s*., decorticated arachis at 13*s*., coconut at 12*s*., and palm kernel meal at 8*s*., all per cwt. to large buyers, London.

SPICES.—Black pepper is slightly dearer and there has been more enquiry. White pepper has also sold more freely, and both spot and forward prices are about ½*d*. per lb. higher. Cinnamon continues scarce and higher prices are asked for all descriptions. Mace is firm at the recent advance but the demand is temporarily less active. Nutmegs have been quiet, but supplies are restricted both of East and West Indian.

COFFEE IN HAITI.

According to the Monthly Bulletin of the American Chamber of Commerce of Hayti for July, 1924, coffee constituted 74·5 per cent. of the exports of the Island. In the fiscal year ending September 30, 1923, this amounted to a total value of $10,864,209 and during the following seven months to April, 1924, to a value of $9,059,065, while it is estimated that about 64,500,000 pounds may be shipped during the present fiscal year. This amount, although only about 88 per cent. of that exported in the previous fiscal, year will have a value approximately equal to it on account of the higher prices received. The principal agricultural products exported from Haiti after coffee are cotton, sugar, logwood and cacao. The values given for these products exported for the seven months ended April 30, 1924 are :—cotton, $1,411,869; sugar, $478,527; logwood, $233,132; cacao, $79,709.

CACAO IN BAHIA.

The rapid increase of cacao production in the Gold Coast has been given as the cause of the slump in the cacao market in the past few years. According to a note in the *Tea and Coffee Trade Journal* Vol. 47, No. 2, the Bahia cacao industry parallels that of the Gold Coast to some extent both as to the amount produced and as to the rate of growth.

The facts and figures refer to the complete statistics for the Bahia cacao crop for the year ended April 30, 1924. They show that the area planted in cacao was 326,178 acres, and that the crop produced was 1,104,560 bags (132 lb. per bag) this amount being second only to the crop of the Gold Coast. It is expected that the present crop will be much less than the record one of 1923-24, as it is usual for cacao to bear heavy crops in alternating and not in successive years.

BRITISH GUIANA: SEAPLANE FOR MALARIAL PATIENTS.

It is reported from London that a seaplane, specially designed to carry men who fall ill with fever on the plantations to the nearest place where they can obtain treatment, has been built for service in British Guiana between a number of company plantations and the nearest township. Hitherto when men became ill it required nearly 17 days to cover the distance of 200 miles by river boat, owing to the many rapids necessitating portages, and many died before they reached the town. The plane, which would be summoned by wireless, can accomplish the distance in a little more than 2 hours.